RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #14

CPR Clarification

Presented by William Harman

SUMMARY

Two current action items involve CPR. In Action Item #13-03, I was requested to distribute a copy of Ed Bayliss's draft technical report on CPR, and in Action Item #9-3, Jim Maynard and I were requested to provide any needed changes to the CPR definitions in the MOPS to make sure that the NL function is clearly defined, especially for exactly 87 degrees latitude.

The Bayliss report will need more work before it is ready, but I think we can expect it to be available in time to be a reference in the MOPS.

This Working Paper proposes a simple change to the CPR definition in Appendix A, intended to resolve the issue of 87 degrees. I have also studied the related issue considered previously, regarding the entries in the last row of Table 2-90. We adopted a change in these values in Meeting #2 (Jan. 01), and I now confirmed that those values are appropriate.

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Two current action items involve CPR. In Action Item #13-03, I was requested to distribute a copy of Ed Bayliss's draft technical report on CPR, and in Action Item #9-3, Jim Maynard and I were requested to provide any needed changes to the CPR definitions in the MOPS to make sure that the NL function is clearly defined, especially for exactly 87 degrees latitude. I was not able to coordinate the following material with Jim before submitting this Working Paper, but will do that as soon as possible.

Bayliss Technical Report. The technical report being written by Ed Bayliss will need more editing of the text before it is ready to be distributed. The technical material appears to be satisfactory as it stands, but the accompanying text, which provides background and describes the evolution of CPR, will need editorial work.

87 Degrees Latitude. There has been an issue regarding the latitude transition at 87 degrees, where NL changes between 2 and 1. This transition is of particular concern because this is the only case in which and encoded latitude occurs exactly at a transition between two NL values (and this exact agreement occurs only for the even format). The discussion in WG-3 has been focused on the need to make it clear to ourselves which value of NL is defined at that latitude, and to make this clear to readers of the MOPS.

The correct value of NL at 87 degrees is 2. I'm basing that statement on recent discussions I have had with Ed Bayliss, Bob Grappel, Loren Wood, as well as study of the MOPS (DO-260). In particular, Bob Grappel has located the C-code, which he developed several years ago to perform checks of CPR. This is the code that Bob circulated to avionics manufacturers for use in implementing CPR.

MOPS Change. It occurred to me while working on this, that the following relatively simple wording change will satisfy our goal to make this definition clear to MOPS readers.

In section A.7.2, part 2-d defines the function NL(lat). Note the sentence beginning, "For latitudes at or near the N or S pole,...". I suggest replacing the remainder of this paragraph with the following:

> The following latitudes the NL function is defined as:
>
> For lat = 0 (the equator), NL = 59;
>
> For lat = +87 degrees, NL = 2;
>
> For lat = -87 degrees, NL = 2.

Last row of Table 2-90. While working on this, I revisited the issue that first raised a concern, which was the last row of Table 2-90. Ian Levitt had done some work on this, and with Jim Maynard's help had developed replacement values for the entries in this row. The values are documented in the minutes from meeting #2.

I studied this issue again by making the diagram shown below in Figure 1, which identifies the encoded latitude values near 87 degrees. Because rounding-off is done in the encoding process, it follows that the real value of latitude where the change occurs from $NL = 2$ to $NL = 1$ is midway between the discrete values in the diagram. Therefore the table entries should be comfortably somewhat away from the change point -- and they are. I'm satisfied that the table entries are appropriate as we agreed in meeting #2.
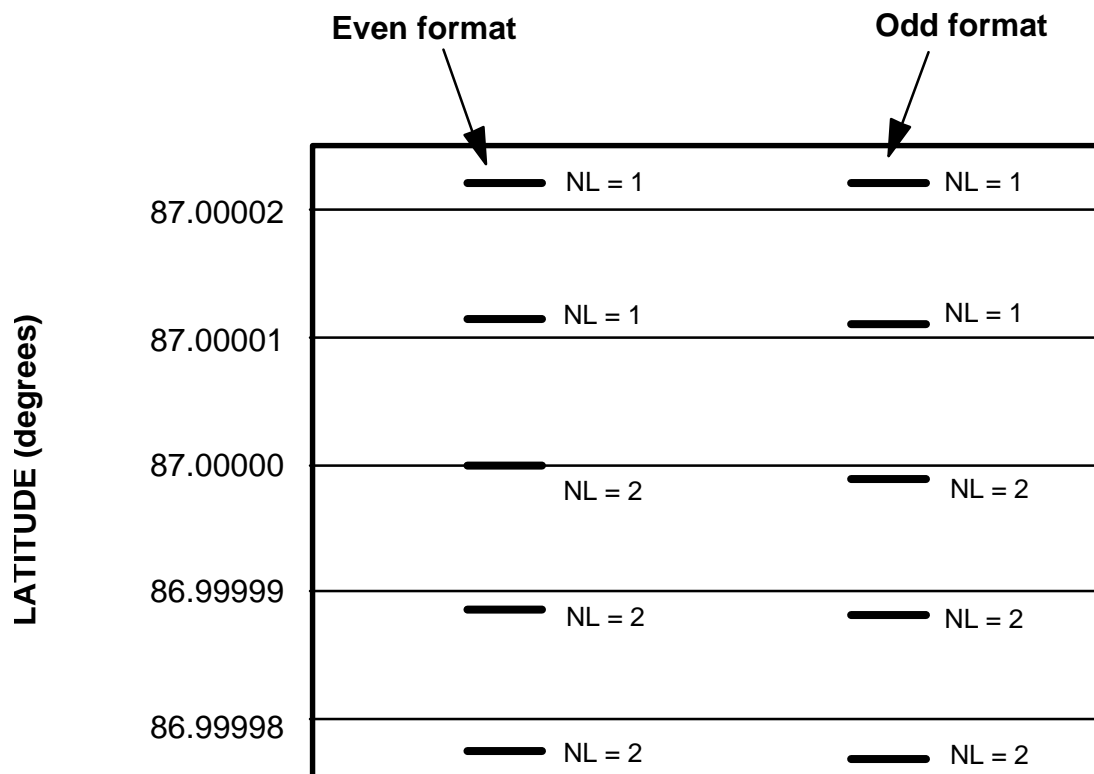
Figure 1. Encoded values of latitude for surface formats.

Supporting Figures. The following figures are provided for more detailed information. Figure 2 is similar to Figure 1, showing the encoded latitude values for airborne formats, whereas Figure 1 applies to surface formats. The final figure illustrates the nature of the multiple CPR solutions at mid latitudes and near the north pole. These apply when a single Extended Squitter message is received of even format.
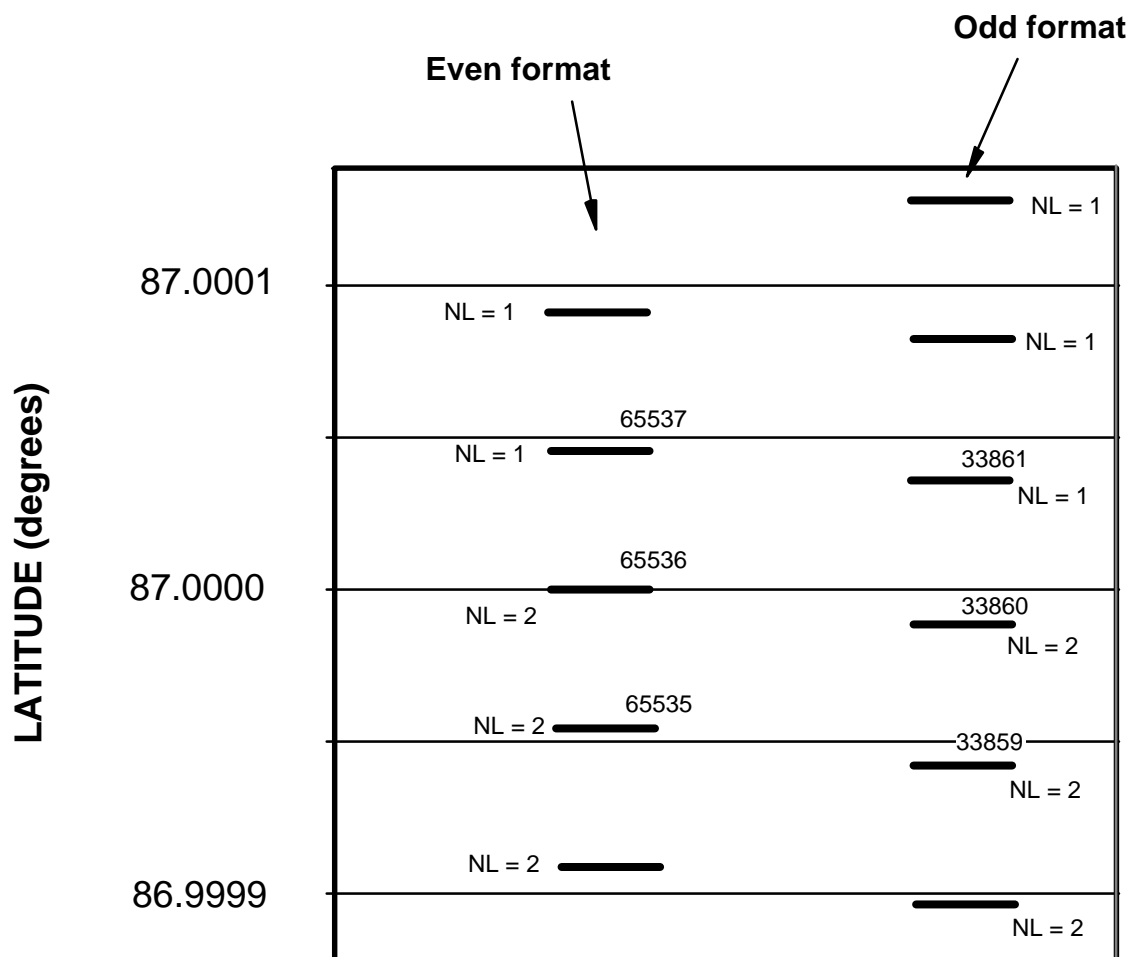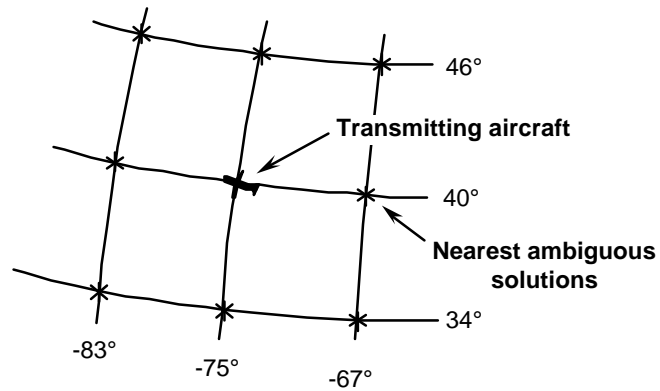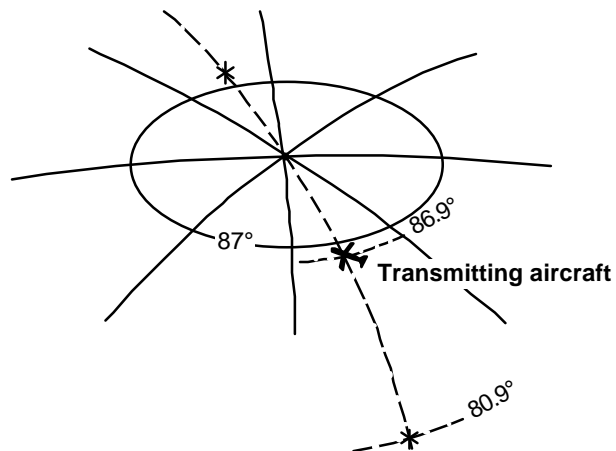
Figure 2. Encoded values of latitude for airborne formats.

Example 1. Mid-latitude (New Jersey)

Transmitting aircraft

46°

40°

**Nearest ambiguous
solutions**

34°

-83°

-75°

-67°

Example 2. Near the North Pole

86.9°

87°

Transmitting aircraft

80.9°

Example 3. Nearer to the North Pole

87.1°

87°

Transmitting aircraft

81.1

Figure 3. CPR geometries